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Netbook - A Toolset in Support of a Collaborative Learning

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Netbook - A Toolset in Support of a Collaborative and Cooperative Learning Environment

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Abstract

Netbook is a software development/research project being conducted for the DARPA Computer Aided Training Initiative (CEATI). As a part of the Smart Navigators to Access and Integrated Resources (SNAIR) division of CAETI, Netbook concerns itself with the management of Internet resources. More specifically, Netbook is a toolset that enables students, teachers, and administrators to navigate the World Wide Web, collect resources found there, index and annotate those resources, and then organize them in a meaningful way. In addition Netbook provides the capacity for communication with peers and teachers, enabling students to collaborate while engaged in the aforementioned activities.

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1. Summary

Netbook is an educational software application developed jointly by Odyssey Research Associates and Cornell's Interactive Multimedia Group over the past 12 months. Netbook is designed to allow users to find, organize, and structure the information available on the World Wide Web. These functions allow students and educators to add context to the information available on the World Wide Web, which in turn add meaning and relevance. As the body of information on the World Wide Web becomes increasingly larger and more unwieldy, the ability to give it context and meaning increases in relevance. The overall development strategy for the first iteration of Netbook was to implement these base functionalities independent of a specific domain of application. Once this preliminary system was developed, evaluated, and refined, the project could be given a domain specific interface. The accomplishment of the second phase of this strategy, creating a domain specific interface, would be entirely dependent upon the extension of project resources, and therefore was not addressed during the first twelve months of the effort. The base functionalities were designed and developed and then subjected to formal usability tests. The results of these tests, as documented in the special technical report delivered at the conclusion of the Netbook project, led to various modifications to the system, both major and minor. In its final state, Netbook is an application that enables users to engage in the following activities: access the World Wide Web; collect and annotate information on the World Wide Web; structure collected information and annotations into hierarchical units; "browse" information structures; and communicate in real-time via a text based chat mechanism.

2. Introduction

The quantity of information available on-line has increased enormously in recent years, as have the number of tools available to access that information. Yet there has not been much growth in the availability of tools designed to structure this information in relevant and meaningful ways. Without tools of this type students and faculty members are often unable to make full use of the available information, and frequently feel overwhelmed by the vast unstructured resources available online. The Netbook project is being developed by Odyssey Research Associates and the Cornell Interactive Media Group to address these issues.

The general purpose of the Netbook project is to add value to the information available online for both students and faculty members, by developing a collaborative environment within which that information can be effectively accessed, stored, annotated, and structured. The end product is a prototype tool, the Netbook, that provides users with the capacity for cooperating in cross-application retrieval and organization of digital information, within a networked educational environment. In addition to facilitating the collection of materials, the tool encourages customization over the search and re-organization of retrieved materials. The Interactive Multimedia Group at Cornell has been studying how students and faculty members retrieve materials from small multimedia databases, and how such users collaborate within a digital environment. These studies

informed the decisions made in the initial development of Netbook's minimum specifications. According to these specifications, Netbook allows users to:

- navigate online databases
- structure their searches
- select entire text documents
- select portions of text
- select entire images
- select portions of images
- title and annotate their selections
- arrange and organize collected information
- save the information regarding their selections (titles, annotations, and pointers to their selected materials)

With the base functionality in place, a formative usability test was conducted. The results of these initial studies will assist in better anticipating users needs in larger digital libraries and in informing the further design of prototype tools.

3. Methods, Assumptions, and Procedures

The primary vision guiding the definition and development of Netbook was a domain independent tool that would allow cross-application retrieval and organization of digitized information. The secondary vision involved shaping the tool in a way that is specific for educational applications. The reason behind this ordering of priorities follows the logic that if the primary functionalities are fundamentally flawed, then applying these funtionalities in real-world settings will prove problematic. The primary investigators sought to avoid the confusion that could occur from attempting to simultaneously solve two independent problem sets. Therefore, it was decided that the two problem sets, one being the development of robust functionality and the other implementing it within a particular domain, would be worked on independently. Thus, this first effort concentrated on defining and developing the functional components required to realize the previously mentioned vision.

Because of this, the following development sequence was planned and adhered to during the Netbook development: step one was to determine the functional components that would be required to allow cross-application retrieval and organization of information; step two was to architect these functionalities; step three was to develop these functionalities in a domain generic format; step four was to evaluate them; and step five was to use the evaluation data to inform revisions and further additions. The next step, which would be dependent upon the extension of the Netbook project, would be to reshape the interface in a way that is specific to the educational domain.

While Odyssey Research Associates and Cornell worked together during all of the previously mentioned development phases, ORA assumed primary responsibility for the technology and Cornell for the theory. Cornell established the theoretical framework for Netbook which then motivated all subsequent design decisions. Cornell also organized and conducted the mid-project evaluation. ORA assumed much of the actual development responsibility, building the system and making sure that it conformed to the design

decisions. This division of labor, and the natural way in which it fit the capabilities of each party, made for a successful and productive relationship.

The functional specification, developed during the initial stages, detailed the individual components of Netbook and the way these components would interact with one another and with the user. This formal document served as a blueprint for the coding of the first iteration of Netbook. Before coding began, it was known that a specific window of opportunity existed for Netbook to be evaluated, and that window would not allow for a complete version of Netbook to be constructed in time. Therefore, priority had to be placed upon certain components so that an incomplete version of Netbook could be constructed that would still yield meaningful results when tested. According to the functional specification, Netbook consists of three general components: one allowing for the collection of data from the World Wide Web, another for the organization of that data, and another allowing students to perform the previously mentioned functions collaboratively in a distributed environment. In deciding which components to include, and which to leave out, one important assumption was made. In any environment, collaboration is a complex process with many potential pitfalls. If the tools that are being used to collaborate are fundamentally flawed, the potential complications would be compounded. Therefore, before the issue of collaboration could be dealt with, it was first imperative to ensure that the tools used during collaboration were sound. This would involve studying them outside of a collaborative environment. Using this principle, it was decided that developing the collection and organization components of Netbook first would be the most practical and useful approach to coding Netbook.

The decision to develop the collection and organization mechanisms for the evaluation obviously had a direct impact on the variables that would be selected for tracking. The variables chosen would need to focus upon: how these mechanisms were used, how much time and effort were required to use them, whether users liked these methods or preferred other readily available alternatives, and whether or not the tool helped users fill their general need to add structure and order to resources available on the Web and the research process in general. In order to establish or simulate the conditions where the "need" for structure and order was present, we asked students to find out how to construct a solar oven (information about this topic is readily available on the World Wide Web). Once these conditions were formalized, a schedule was developed, the proper facilities and equipment were secured, and the evaluation was conducted.

Preliminary data from the evaluation indicated the need for several changes to the current system. One fundamental correction stemmed from our incorrect assumption that, since the target user group was young, that they were technologically naïve as well. Because of this assumption, it was decided that the Netbook interface should be quite structured, perhaps mimicking the actual processes for which it will be used. However, during the evaluation, it was discovered that youth did not imply technological naiveté. Users felt restricted by the structure imposed upon the interface. Therefore, it was decided that users should be given greater power to customize the interface to best suit their needs. This and other information led to various changes to the system.

During the final stages of development, there were three primary concerns: to implement some of the changes recommended during the evaluation, to add real-time communication capabilities to Netbook, and to prepare Netbook for either the test-bed or the conclusion of the project, whichever came first. The real-time communication was implemented with a text-based chat mechanism. This introduced a chat server into the tool suit. Also, as mentioned above the interface was made more configurable, and the structuring mechanism was made much easier to use. After these additions were made, we completed the second iteration of Netbook.

4. Results and Discussions

The Functional Components: Overview

Netbook consists of three primary components: a project repository, a resource viewer, and resource annotation tools. As the name implies, the project repository provides an interface to Netbook projects, which may be accessed, or created, through the project repository. A Netbook project is a hierarchical unit made up of folders, each of which can contain one or more web pages (in practice these can be either pointers to web pages or the actual pages themselves), bitmaps, sound and video files. Support for additional file formats may eventually be included. The resource viewer contains a browsesr that allows each of these resources to be viewed, and also provides access to the World Wide Web. Using the hierarchical organizer and the viewing context simultaneously, users can search for new resources, view them, and collect them by dragging and dropping or using the collection tools. Users may also "browse" through a project in the logical sequence in which it was assembled by scrolling through it, or view any individual object by dragging it from the organizer to the viewing context. Additionally, each individual object within a hierarchy may be annotated (including web pages or selected portions of web pages that have been collected) using Netbook's annotator.

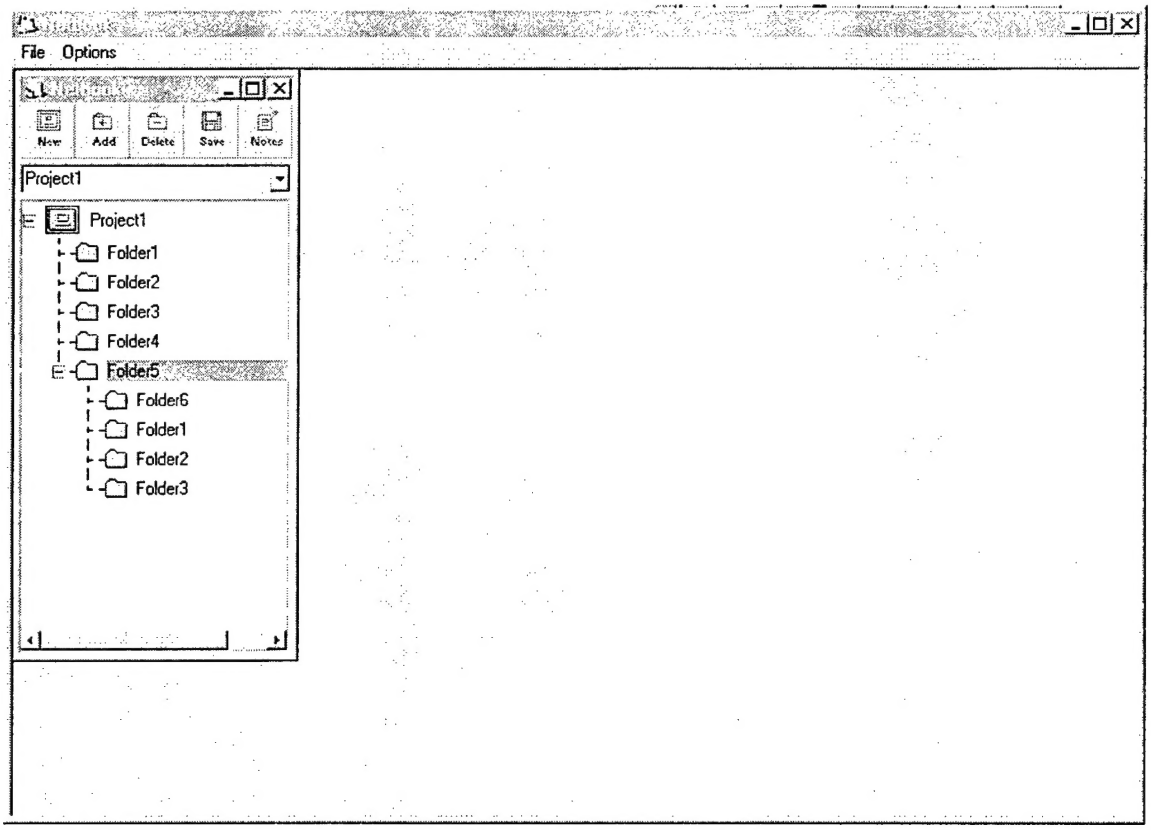

Figure 1: the organization interface of the project repository

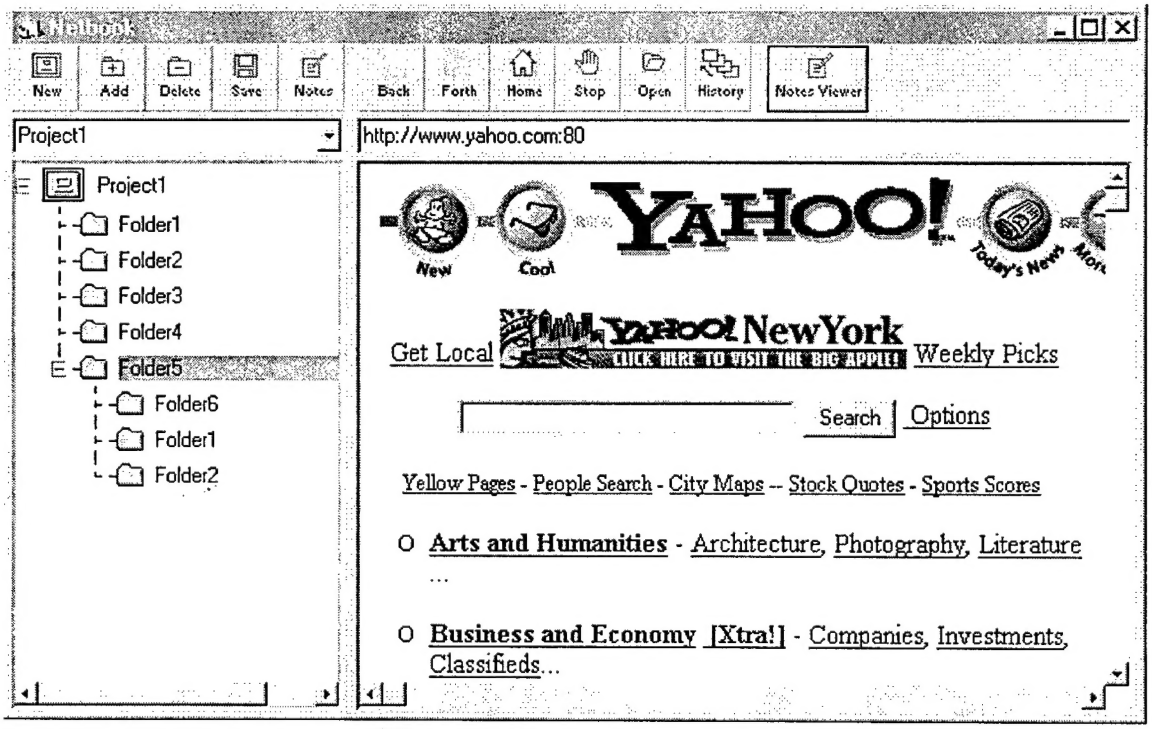

Figure 2: the resource viewer

The Functional Components: Details

General Issues

Netbook users have a great deal of flexibility in configuring the interface. They may work with one of the components, with all three of the components simultaneously, or with multiple instances of each component simultaneously. Each component is both movable and sizable, thereby allowing each user to arrange the work space in the way that is most comfortable for them. Netbook supports four primary activities: searching for resources, collecting resources, annotating resources, and organizing resources.

Organizing Resources: the Project Repository

The organizing component allows resources to be structured in a hierarchical fashion. The organizer houses the contents of a project. A project houses three primary types of objects: project objects, container/folder objects, and resource objects. At any given time, an organizer can contain only one project (although as mentioned earlier, multiple project repositories can be open simultaneously). Projects can contain a variable number of folders, and folders can contain any number of resources and additional folders. The current list of resource objects that can be contained in the repository (and viewed in the viewing context) include: HTML documents, MS Word documents, WordPerfect Documents, AmiPro documents, Excel spreadsheets, ASCII text files, bitmaps, jpegs, gifs, wav files, and avi files. Future versions may support Java applets, ActiveX components, and other multimedia files. The hierarchy resembles directories found on today's popular desktop PCs with at least one subtle and yet important distinction: the organizer does not enforce the alphabetical sequencing of its contents. This gives users greater power over the logical structuring of their resources, and permits them to think of their hierarchy in terms of an outline (which should be a more familiar concept for most students than a directory).

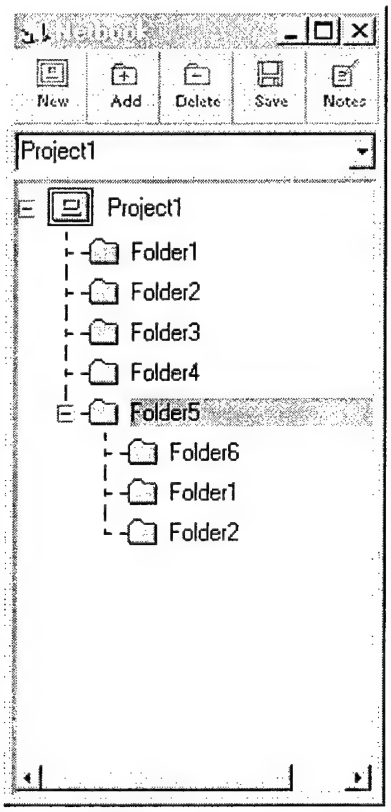

Figure 4: the project repository

The organizer has buttons to open a project, add folders, subtract folders, expand the hierarchy, collapse the hierarchy, and to search the project. The search mechanism (see figure 10) in the initial version will search the titles and annotations associated with each resource. Future versions will support searching the text body of each resource, as well as outputting the name and e-mail address of the individual responsible for the creation or submission of certain resources. In addition, future versions will support access control over the elements in the organizer.

Searching for resources: the Resource Viewer

The primary source of content for the discovery of resources in Netbook is the World Wide Web. The resource viewer is a viewing context which allows, among other things, Web browsing. The embedded web browser supports many of the operations of the current popular web browsers (although at this time it does not support Java applets, ActiveX components, Shockwave applications or any other "active" content). The browser uses standard navigational tools for browsing: the home button, the back button, the forward button, and the stop button. The browser also includes a history button that allows the search path to be viewed, and a button that allows the viewer to access the local hard-drive from within the browser. The browser can be open and closed by clicking on a button present in the organizer (see figure 4) which either expands or collapses the project repository.

Annotating Resources: the Annotator

After users have engaged one of the collection tools provided with the browser, and selected a resource to collect, they are given the opportunity to annotate that resource (in practice, users can annotate a resource at any time, not just as it is collected). Annotation is accomplished with an annotation dialogue which displays the selected resource, indicates the folder in which it will be placed (a folder refers to an object in the organizing portion of the project repository), indicates the URL where the resource resides, and invites the user to enter a title and a variable length annotation. At this point the user can be either execute or cancel the operation by clicking on the appropriate button.

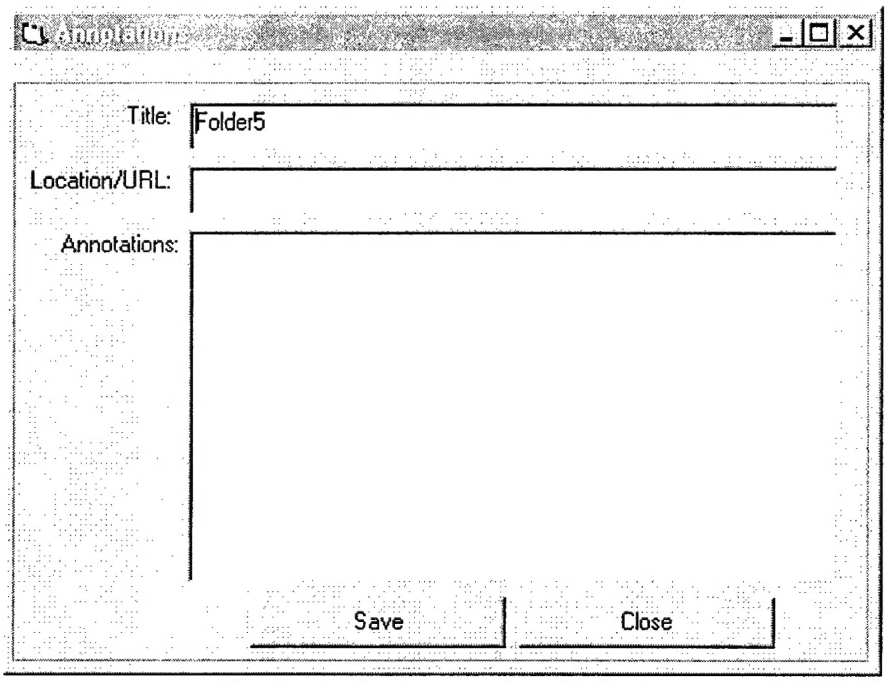

Figure 5: the annotation dialogue

5. Conclusions

The tool suite developed during the first stage of the Netbook project can be viewed as an assembly of functional components that can be used in concert toward positive educational ends, but are independent of any particular occupational domain. In other words, while Netbook can be used for various educational purposes, it can also be used outside the realm of education. This approach emphasizes maximum flexibility of use and independence from any one pedagogical philosophy. However, in an effort to fit Netbook naturally into the current educational environment, any future development efforts will largely focus upon wedding the Netbook tool suite to existing educational practices. The underlying assumption follows the argument that educators will more readily adapt tools that fit into their current teaching philosophies, and allow them to use new media to continue implementing "best practices" that have taken them years to develop. Once adaptation is achieved, educators will feel more comfortable expanding their repertoire of core skills to include the new pedagogical practices that computer based technologies can realize. Following this theme, future Netbook efforts will provide support for core pedagogical skills by allowing for teacher guided instruction across broad distances of time or space, and teacher mediated collaboration among groups. At the same time, Netbook will expand upon these core processes by allowing for a richer variety of interactions and media for communication than is currently possible, "discovery learning" with varying degrees of learner control, individualized learning paths, and greater ability to track and respond to the individual needs of the learners. Three primary methods will be employed to accomplish this: major modifications to the interface, and various expansions of the existing functionality, and the exploitation of other CAETI efforts through meaningful collaboration. These modifications combined with the existing effort would make the following activities possible:

- Independent research projects in which a student is assigned or chooses a topic to explore.
- Collaborative research projects in which groups of 2 or 3 are assigned to, or collectively choose a topic to explore.
- Large scale (semester-long curricula based projects), or small scale (unit-based) projects.
- Open projects in which the "questions" being answered can have variable results depending upon the interest and abilities of the students (best for mature students), and more structured projects in which the "questions" being answered have clear answers and the path that the students should travel is clearly defined.
- Teacher moderated distance-learning multimedia interactive lectures where teachers and students alike can either singly or jointly illustrate and manipulate multimedia elements that exist on everyone's screens.

While this list is not exhaustive, it reflects the intent to support as many pedagogical practices as possible, while fitting comfortably into the existing practices of educators and administrators.

Netbook distinguishes itself from other more popular World Wide Web browsers like Netscape and Internet Explorer in several important ways. Some of these distinctions are based upon existing features and others upon features not yet completed. Using traditional browsing tools, organizing Web data into meaningful structures requires using either primitive bookmarking devices or utilizing the operating system's underlying file structure. Both solutions require a shift in context which are intrusive to the browsing process. Both solutions require familiarity with additional processes. And for both solutions, viewing a *single* item from a bookmark tool or OS file system is clumsy, requiring several steps. This makes the task of viewing a *group* of related resources extremely cumbersome. Netbook on the other hand has tightly integrated the structuring and browsing features into the same interface enabling intuitive drag and drop interactions between them. Tightly integrating the browsing and structuring tools enables users to personalize Web based information with greater ease. In addition, the data repositories that Netbook users create will be shared repositories that can be collaboratively constructed across broad distances, either synchronously, or asynchronously. In order to support this activity, Netbook currently enables real-time text-based chat. By extending the communication media to voice and video, and modifying the interface to support familiar educational paradigms, Netbook provides the potential for a robust distance-learning tool supporting many different educational pedagogies, something that cannot currently be accomplished with either Netscape or Microsoft's Internet Explorer.

6. Recommendations

Upon the extension of the Netbook project, the changes to Netbook will be explored and implemented:

Interface changes:

Instead of using traditional computer-based conventions to represent the tools in the Netbook suite, these components will be represented both visually and metaphorically by devices and processes that are familiar to teachers and students in their normal environments. For example, if a project were thought of as a lesson plan instead of a hierarchy or outline (which are more abstract concepts), Netbook would be easier to use, and it would to mesh well with teachers' and students' existing concepts. This would also increase the chances that teachers would invent new methods for its use. Another example of a meaningful interface change would be to represent the viewing context as a blackboard. Attempts will be made to modify the interface in order to more adequately facilitate: the planning of an activity or lesson by the teacher, the creation of a suitable environment for the implementation of such lessons and the expansion of existing pedagogical techniques, and the adequate use and experience of such activities by the participants.

Functional Expansions:

The goal of future iterations of Netbook will be to create a tool that will allow teachers to interact with and guide learners in a real-time group learning experience, and simultaneously accommodate individual learning needs by allowing independent pathways

and goals to be established. In order to accomplish this four primary capabilities must be in place: greater real time communication, programmatic control over access to the elements within a "project" or lesson, the ability to identify the individual needs of the learners, and the ability to address those needs with individualized lesson segments if necessary. To facilitate greater real-time communication, voice and video conferencing capabilities will be added to the system. For programmatic control over a lesson plan, a teacher will have the ability to limit access to resources within a lesson plan/project. The teacher can then grant access either manually, through time-based criteria, or through achievement criteria. The creation of audit trails will allow a teacher to monitor the progress of individual students by archiving information regarding their strengths and weaknesses, likes and dislikes, or various other qualities significant to the achievement of instructional goals. Once a teacher identifies discrepancies, they can be addressed by creating independent pathways within a lesson plan. One way this could be done would be to create entirely separate goals and lessons for the students. Another is to create segments within group activities that diverge to meet special needs, and then converge with the group plan at later points.

With these interface and functional issues addressed, the Netbook system will be a very robust, all purpose educational tool with a broad range of application and a relatively small learning curve, which fits comfortably into existing pedagogical practices, while simultaneously expanding them.